



Estimation of Workload by Position in Volleyball

تقنين حمل التدريب حسب المراكز في الكرة الطائرة

Benchetioui Abderrazak (D) Lecturer.

Université d'Alger 3 A.Benchetioui@Yahoo.com

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Abstract:

Unlike many team sports, each position in volleyball possesses distinct characteristics; the duration, distance, and speed of operations as well as the time spent on the court during actual gameplay. These latter two pieces of data allow us to determine the effort-to-recovery ratio for each player in our study.

Equipment and methods: In the scope of this statistical study utilizing video analysis tool (Kinovea software), we sought to evaluate the number of operations performed by each player of the Algerian volleyball team during the last edition of the 2023 African Cup of Nations (CAN) held in Egypt. We selected two matches of different levels and intensities. The first being Algeria vs. Libya (3-2, in the semi-final), and the second Algeria vs. Egypt (3-0, first round).

Results: According to the results obtained, we observed during this study a balancing effect among the players during the different matches, where the workloads were evenly distributed among the players across different levels of match intensity.

Keywords: Volleyball, position profiles, Effort/recovery report

1. INTRODUCTION

Sports coaching has been encouraged to organize and plan training based on new discoveries regarding training organization. Today, it is evident that physical preparation is a key element of training. The development of physical qualities involves preparing an individual, a team, or even an animal for sports performance through adapted exercises. Sports performance depends on a set of interconnected factors that are essential for reaching an optimal level, especially in high-stakes competitions such as international tournaments. Performance is influenced by several factors, including endurance, speed, strength, and prophylaxis.

Speed is also considered a key performance indicator in many sports. Training programs aimed at improving speed focus on :

- Muscular power (ability to generate maximum force in a very short time).
- Neuromuscular reactivity (speed of nerve signal transmission and muscle activation).
- Movement technique (efficiency of movements, posture, and coordination).

Regardless of how it is expressed, speed represents the ability to move quickly in either cyclic or acyclic motion. Strength, on the other hand, is expressed in Newtons (N) and is represented by a vector to indicate its direction. This mechanical approach to force application is a crucial element in volleyball, particularly during jumps, as well as in attack and defense phases, which involve small running steps, short sprints, and support movements. Physical preparation also includes the prophylactic aspect, which encompasses all measures taken to prevent the onset, spread, or worsening of injuries or illnesses. This term, which emerged in 1793, originates from the medical field and is related to a methodological approach. All these aspects of physical preparation are integral parts of training and depend on the athlete's profile, individual parameters, as well as mental preparation and nutrition. In high-level sports, competition is a key factor in evaluating workload. As Hotz (1994) states: "Training serves for development, while competition serves for performance realization."

Building on this analysis, it is essential to assess the training load imposed during competitions of varying intensity levels to establish benchmarks regarding biomechanical and bioenergetic demands specific to volleyball, which we have chosen to analyze.

Regardless of their level of play or physical condition, volleyball players must plan their training based on their position-specific profile and the development of various physical qualities required for high-level performance.

The primary question posed is: **What are the physical characteristics required to play high-level volleyball?**

By further examining this topic, we ask: **What are the fundamental actions that define volleyball gameplay?**

It is possible to categorize six main actions that structure the game:

- **Serving**
- **Receiving**
- **Setting**

- **Attacking**
- **Blocking**
- **Defending**

To enhance athletes' performance, numerous studies have been conducted to better understand the specific characteristics of each playing position.

For instance, during the 2010 Volleyball World Championship (both men's and women's), statistics were gathered on player ages and heights (excluding liberos) as part of the Athlete Development Model in Volleyball (2013-2017, Volleyball Québec).

Other research has focused on volleyball players' workload during matches. For example, Fontani et al. (2000) compared match characteristics across three-set and five-set games, analyzing key aspects such as:

- **Effective playing time**
- **Number of actions per match**
- **Average action duration**
- **Interval time between plays**
- **Percentage of exchanges based on total match time**

These studies demonstrate that significant differences exist between volleyball positions, whether in terms of **morphology, physical demands, or nutritional needs**.

This raises several critical questions:

- **Are there significant workload differences between positions during a match? If so, what are they ?**
- **Should physical preparation be adapted to each position? If so, how ?**
- **Should training plans be individualized for each position? If so, in what way?**

This study aims to **analyze the Algerian national volleyball team**, which competes at the international level, to quantify the workload for each position during two matches of medium and high intensity.

To ensure precise quantification of training load, we have chosen to track the **same athlete** across both matches.

To conduct this study, we will examine various in-game variables in volleyball to better understand the physical workload of elite players, including:

- **Player presence time and actual action time per match and per set**
- **Recovery time per match and per set**
- **Effort-to-recovery ratio**

2. Methodological Framework

2.1 Analysis Method

The objective of this study is to quantify the workload of each volleyball player during two matches of different levels in terms of points and sets and then compare them, along with the results of various match variables, for each player.

The choice of video analysis is not accidental, as it allows for a detailed examination of the players' workload. This method enables us to precisely quantify each action and movement performed by the players.

2.2 Choice of Collected Data

The objective of this study is to determine the workload performed by each player during two matches of different intensities (moderate and high) for various categories of actions in volleyball. We focused on game actions such as approach runs, dives, and block jumps, while considering other actions, such as positioning adjustments, as non-significant since they represent recovery time.

During data collection, we only retained movements aimed at touching or supporting the ball. This does not necessarily mean that the player touches the ball each time they perform such a movement. Some actions, such as approach runs or block jumps, may be executed without the player making contact with the ball.

As part of this research, we analyzed two matches played by the Algerian national volleyball team during the latest edition of the 2023 African Nations Championship (CAN) held in Egypt. The two matches were classified into two intensity groups based on the number of points and sets played, as the score alone does not fully represent the intensity level.

To ensure meaningful tracking, we chose to follow the same athlete across both matches. This approach aimed to achieve the most accurate quantification of the training load based on the player's position.

2.3 Data Collection Method

The analysis technique used for this study combines Microsoft Office Excel with video analysis. The specificity and precision of the results we aimed to obtain required us to create our own data collection system and statistics using Excel.

The objective of this data collection was to record each significant action performed by the player based on its purpose (approach runs, support runs, etc.) and to determine the type, number, distance, duration, and speed of these actions.

For distance estimation, we combined the grid available in Kinovea, which divides half of the court into quadrants (Fig.1 top), with a custom grid we developed, accurately representing player positioning in meters (Fig.1 bottom).

Figure 1. Top: Reference grid on half a court (9 x 9 m) using Kinovea software. Bottom: Excel grid representing the distances covered by players with corresponding coordinates (distances in meters).



Corresponding author: Benchetioui Abderrazak

E-mail: A.Benchetioui@Yahoo.com

3. RESULTS & ANALYSIS

3.1 Player Presence Time & Actual Action Time:

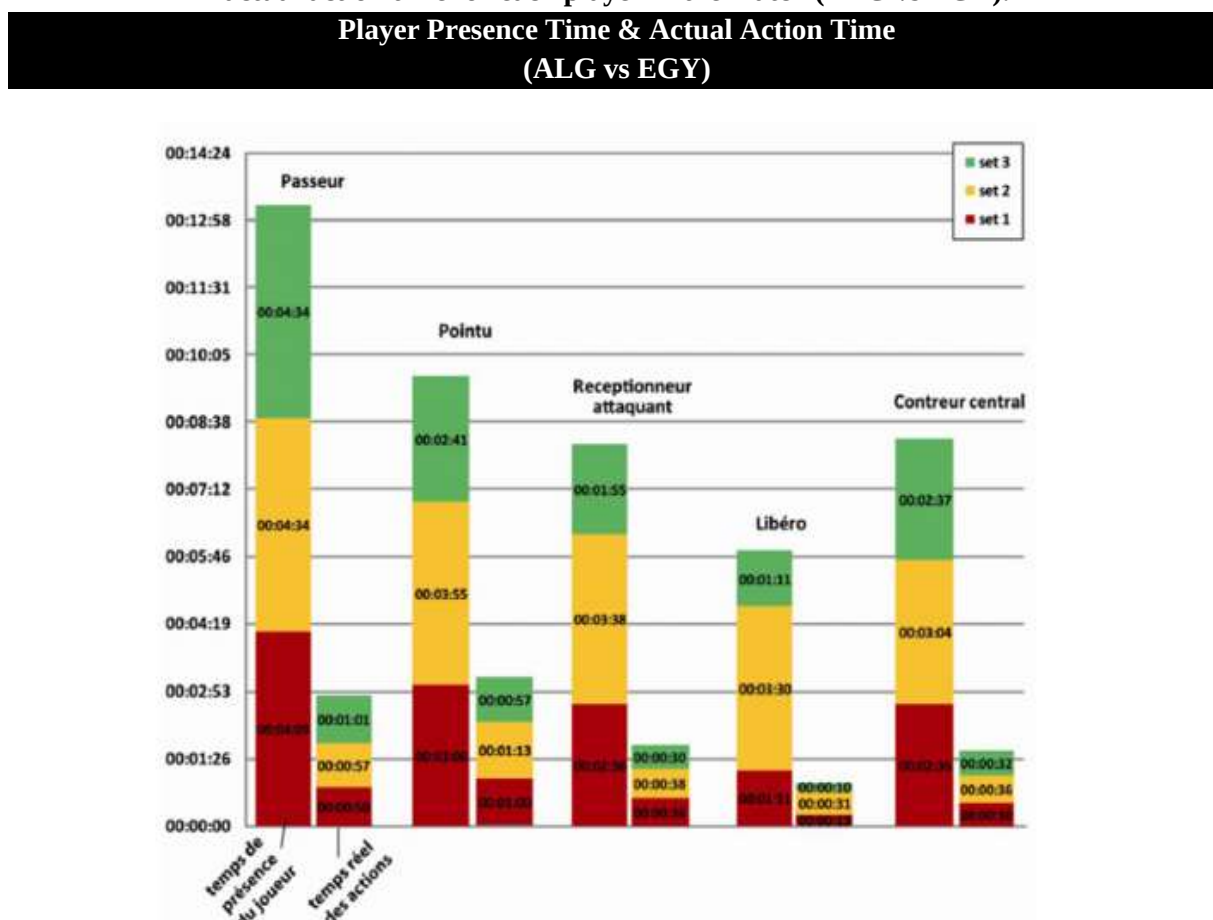
Initially, we focused on the playing time. Indeed, it is important to know the player's presence time and the actual action time during a set and across matches of varying intensity in order to achieve a more precise and accurate analysis of the different position profiles.

The player's presence time on the court corresponds to the total duration of all points played throughout a match.

To calculate this value, we subtracted the start time of each point from the end time and then summed it over all points in the match.

The actual action time, on the other hand, represents the total duration of operations performed by each player throughout the match. We subtracted the start time of each operation from the end time corresponding to it.

Figure 2: Diagram representing the comparison between the player's presence time and the actual action time for each player in the match (ALG vs EGY).



Comparison between the player's presence time and the actual action time for each player in the match (ALG vs EGY).

Tableau 1.

Temps de présence du joueur	Passeur	Pointu	Recept-attaq	Libéro	Cont central	temps réel du match
set 1	00:04:09	00:03:00	00:02:36	00:01:11	00:02:36	00:04:11
set 2	00:04:34	00:03:55	00:03:38	00:03:30	00:03:04	00:05:47
set 3	00:04:34	00:02:41	00:01:55	00:01:11	00:02:37	00:04:34
total	00:13:17	00:09:36	00:08:09	00:05:52	00:08:17	00:14:32
% tps de jeu	91,40%	66,06%	56,08%	40,37%	57,00%	

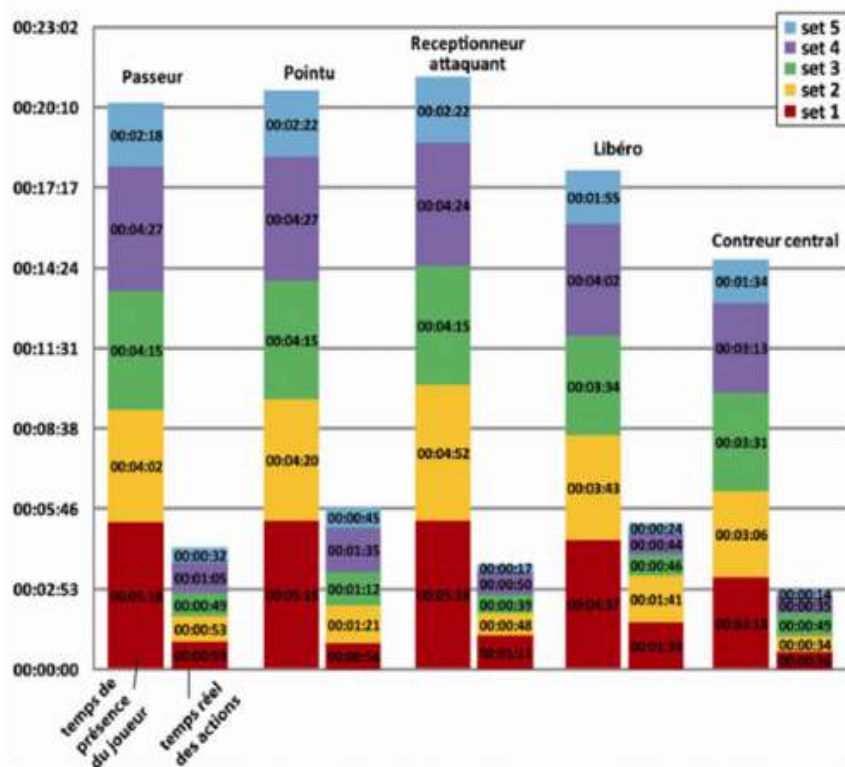
Temps réel des actions	Passeur	Pointu	Recept-attaq	Libéro	Cont central
set 1	00:00:50	00:01:00	00:00:36	00:00:13	00:00:30
set 2	00:00:57	00:01:13	00:00:38	00:00:31	00:00:36
set 3	00:01:01	00:00:57	00:00:30	00:00:10	00:00:32
total	00:02:48	00:03:10	00:01:44	00:00:54	00:01:38

For the ALG vs EGY match (Fig. 2 & Table 1), the setter has a very high presence time on the court (91%), which is significantly higher than the other players (outside hitter = 66%, receiver-attacker = 56%, libero = 40%, and middle blocker = 57%).

The actual action time is not necessarily consistent with a player's presence time. For example, the outside hitter has a presence time of 66%, but he has the longest actual action time (3' 10"; Table 1).

Figure 3: Diagram representing the comparison between the player's presence time and the actual action time for each player in the match (ALG vs LYB).

Player Presence Time & Actual Action Time (ALG vs LYB)



Comparison between the player's presence time and the actual action time for each player in the match (ALG vs LYB).

Tableau 2.

Temps de présence du joueur	Passeur	Pointu	Recept-attaq	Libéro	Cont central	temps réel du match
set 1	00:05:18	00:05:18	00:05:18	00:04:37	00:03:18	00:05:18
set 2	00:04:02	00:04:20	00:04:52	00:03:43	00:03:06	00:04:52
set 3	00:04:15	00:04:15	00:04:15	00:03:34	00:03:31	00:04:15
set 4	00:04:27	00:04:27	00:04:24	00:04:02	00:03:13	00:04:27
set 5	00:02:18	00:02:22	00:02:22	00:01:55	00:01:34	00:04:44
total	00:20:20	00:20:42	00:21:11	00:17:51	00:14:42	00:23:36
% tps de jeu	86,16%	87,71%	89,76%	75,64%	62,29%	

Temps réel des actions	Passeur	Pointu	Recept-attaq	Libéro	Cont central
set 1	00:00:59	00:00:56	00:01:11	00:01:39	00:00:36
set 2	00:00:53	00:01:21	00:00:48	00:01:41	00:00:34
set 3	00:00:49	00:01:12	00:00:39	00:00:46	00:00:49
set 4	00:01:05	00:01:35	00:00:50	00:00:44	00:00:35
set 5	00:00:32	00:00:45	00:00:17	00:00:24	00:00:14
total	00:04:18	00:05:49	00:03:45	00:05:14	00:02:48

For the ALG vs LYB match (Fig. 3 & Table 2), the setter, outside hitter, and receiver-attacker have a significant presence time on the court (respectively 86%, 88%, and 90%), which is slightly higher than the other players (libero = 76% and middle blocker = 62%).

Here, the outside hitter has the longest actual action time (5' 49"), followed by the libero (5' 14"), the setter (4' 20"), the receiver-attacker (3' 45"), and the middle blocker (2' 48").

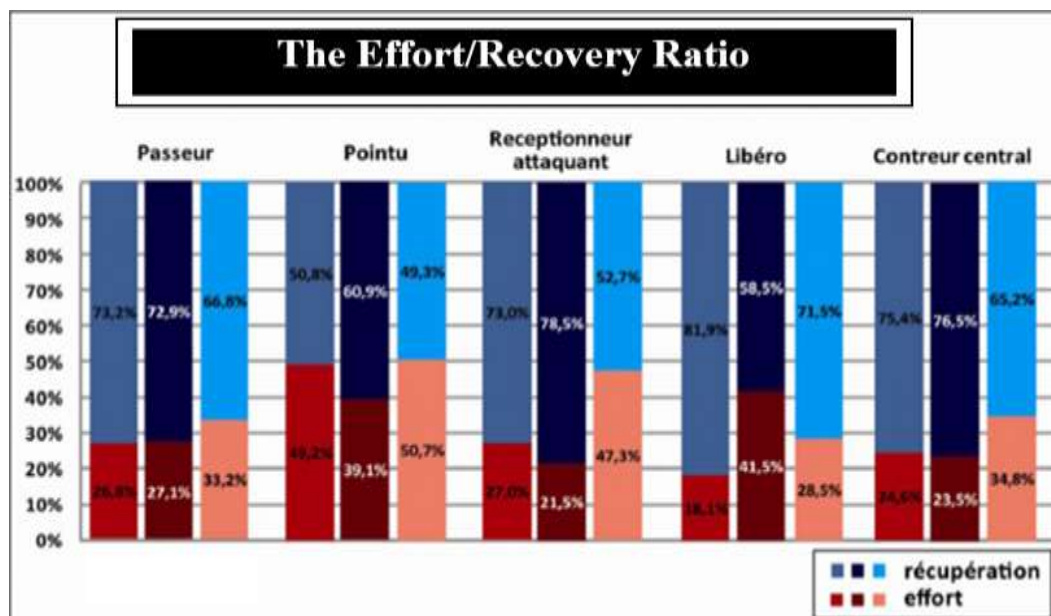
3. 2 The Effort/Recovery Ratio:

The effort/recovery ratio is an important factor, especially in managing training load in order to accurately recreate competition situations.

To calculate this ratio, it was necessary to gather all the data. This allowed us to determine the effort-to-recovery ratio during a set and a match, and compare it across matches of different intensities (Fig. 4).

To calculate this value, we divided the actual action time by the recovery time, which is the difference between the presence time and the actual action time.

Figure 4: Diagram representing the effort/recovery ratio for each player across the two matches.



Regarding the effort/recovery ratio, differences can be observed between the two matches.

For the match against Egypt, the outside hitter has an effort/recovery ratio close to one-to-two, while the other players range between one-quarter and one-sixth. Consequently, the outside hitter exerts approximately twice as much effort as the other players.

For the match against Libya, the libero and outside hitter have an effort/recovery ratio of about 40%, while for the setter, receiver-attacker, and middle blocker, it is between 21% and 27%.

Looking at this diagram, all players exerted more effort during the second match (against Libya), except for the libero.

4. Discussion

In this research, we observed disparities between the variables analyzed across all positions, during both matches with different intensities and levels of play. However, we noted that intensity is not directly associated with the match or its outcome.

In reality, intensity depends on the player's time spent on the court but more importantly, on their actual playing time. The effort/recovery ratio, which is the ratio between the time spent in action and the time spent without significant actions, is particularly useful for quantifying intensity.

The five-set match against Libya, theoretically of higher intensity due to the number of sets and points played as well as the international competition level, did not necessarily show a higher effort/recovery ratio for each player compared to the other matches.

Furthermore, this ratio varied from player to player, indicating that intensity differs between players. The analysis of the outside hitter and the setter's play supports the idea that intensity is specific to the player, not just the assumed intensity level of the match.

These observations lead us to show that there is a balance in the efforts among players during a match, creating a balancing effect. Indeed, when one or two players exert less effort, others compensate by performing more actions.

Our initial hypothesis was to determine whether there is a significant difference in the workloads of different positional profiles during a volleyball match, and whether specific physical preparation should be considered for each position.

Our study, conducted over two matches of varying levels, confirmed our hypotheses. Differences in the duration of actions, their distances and speeds, as well as the time spent on the court, the actual time spent performing actions, and the effort/recovery ratio were observed. These data are specific to each position and will allow for the development of personalized training.

5. CONCLUSIONS

The data obtained from this research will enable personalized and tailored training for each positional profile to avoid overtraining, which could negatively affect performance during practice sessions.

Today, we know that the factors contributing to overtraining are numerous. Among these, the lack of rest is probably the most obvious, especially when associated with an excessive training load.

The main explanation certainly lies in the covariance of three factors: stress, recovery, and stress tolerance. It seems crucial to be mindful of social stress, which encompasses the stress of training. There are several tools available to prevent overtraining syndrome by considering different parameters, such as the overall quality of recovery measured with the TQR (Total Quality of Recovery; Kenttä, 1996), the perceived exertion rating with the RPE (Ratings of Perceived Exertion; Borg, 1970, 1994) scale, or the POMS test (Profile of Mood States; Berglund, 1996), which help identify this syndrome early.

This study conducted on the Algerian volleyball team opens the door for comparisons with other clubs of similar level. We could also compare our results, particularly regarding the distances and speeds measured, with data obtained from an accelerometer attached to each player to verify the accuracy of our data. This tool has the advantage of being less restrictive for the calculation method but requires calibration with a certain margin of error due to variations in movement (side steps, backward movements, sprinting, etc.).

Furthermore, the value of this study lies in using the collected information during training sessions. For example, the maximum effort/recovery ratio of each player could be used to simulate a match at maximum intensity.

Throughout this study, we observed a balancing effect between players during the different matches, where workloads were evenly distributed among the players, even across varying intensity levels. This observation would be interesting to explore further in a new study to better characterize this effect.

6. References

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